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The Lanby buoy telemetric system

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Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION August 1973

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THE LANBY BUOY TELEMETRIC SYSTEM

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Summary

This report describes a simple telemetric system developed for transmitting field strength data over a short sea path between a navigational bouy moored in the English Channel and the mainland.

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1. Introduction

In extending the u.h.f. televison network to the Channel Islands consideration must be given to the most suitable means of providing a programme feed. Various methods were considered and one suggestion was to use a large automatic navigational buoy (LANBY) moored in the English Channel as a platform for a relay station, and it was in order to investigate reception problems on such a buoy that the equipment described in this Report was constructed.

2. The buoy

The Lanby buoy was designed by Hawker Siddeley Dynamics to a specification issued by Trinity House. It is intended to replace a light vessel at an annual saving in excess of £80,000. The particular buoy used in these trials was designed to replace the Shambles Light Vessel, 8 km off the Bill of Portland.

The buoy consists of a discus hull, 12 m in diameter, 2·5 m deep, and surmounted by a 12 m mast. It displaces about 112 tonnes.

Environmental tests have shown that it is capable of operating under the following conditions.

1. Wind velocity up to 45 m/sec.
2. Wave heights up to 12 m.
3. Sea currents of 7 knots.
4. Mooring depths of up to 50 fathoms.

It houses a main light, a main fog signal and various navigational aids and stand-by equipment. A u.h.f. link provides two-way data traffic on a frequency shift keying system between the buoy and its parent shore station.

The power supply consists of three diesel alternator sets each providing 5 kW continuous rating on an operating schedule which provides for 24 hours running followed by a 48 hour rest period. The buoy equipment is powered from 28 V D.C. derived from a large nickel-iron accumulator which is charged by a static rectifier from the 230 V A.C. output from the diesel alternator. This ensures continuity of the buoy's power supply during 'run up' and change over of the alternators. Service/re-fuelling will probably be at six monthly intervals or as requirements in practice dictate.

The BBC telemetric equipment was powered from the A.C. supply via a solid state RMS A.C. voltage stabiliser.

A photograph of the buoy is shown in Fig. 1.

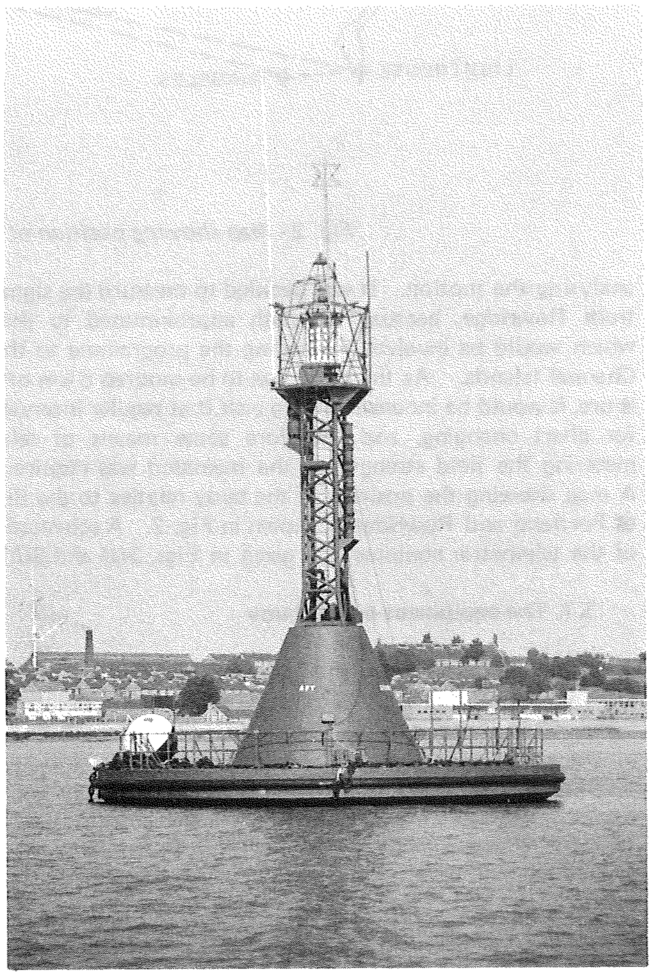

Fig. 1 - Photograph of Buoy

3. The equipment

It was decided during the preliminary study to measure only field strength variations of suitable u.h.f. transmissions on the buoy, and if these looked promising, devise means of

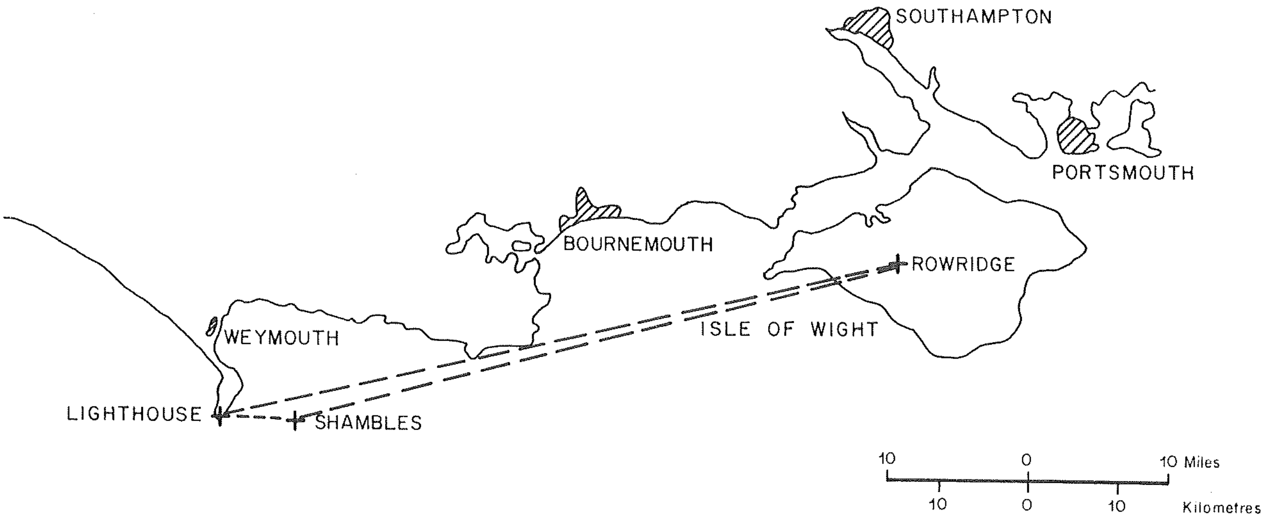

Fig. 2 - Map showing position of Rowridge, Shambles and Bill of Portland

analysing the motion. It was decided to measure the signal from Rowridge, because the path approximated to that which would be involved in feeding the programme to the Channel Islands. As the buoy was to be moored 8 km off-shore, it would be inconvenient to visit it at regular intervals for chart changing, and therefore some means of tele-metering the field strength to the mainland was required. A map showing the position of the buoy relative to the Bill of Portland and Rowridge is shown in Fig. 2. A schematic of the telemetric equipment is given in Figs. 3(*a*) and 3(*b*).

3.1. The equipment on the buoy

The equipment on the buoy consisted of a super-turnstile aerial[1] for the reception of horizontally polarised signals from Rowridge on Channel 31. The polar diagram of the aerial is approximately omnidirectional so that any rotation of the buoy had little effect upon the received signal. The aerial was mounted above the main light at a height of approximately 13 m above sea level. The aerial was connected to a u.h.f. long distance recording (LDR)

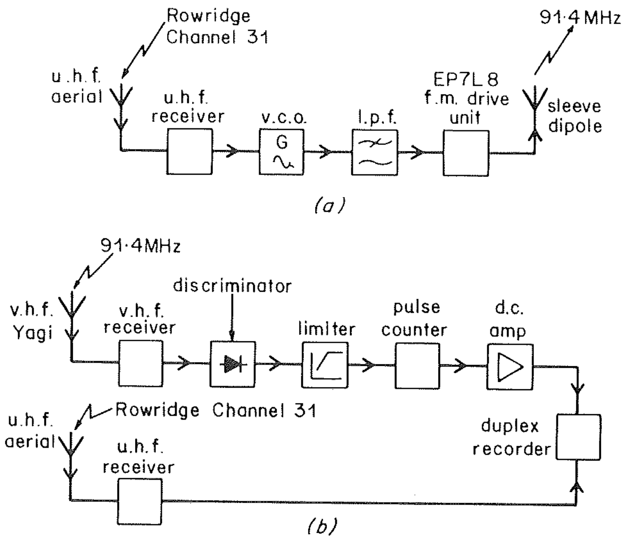

Fig. 3 - Schematic of complete system
(*a*) Buoy equipment (*b*) Land equipment

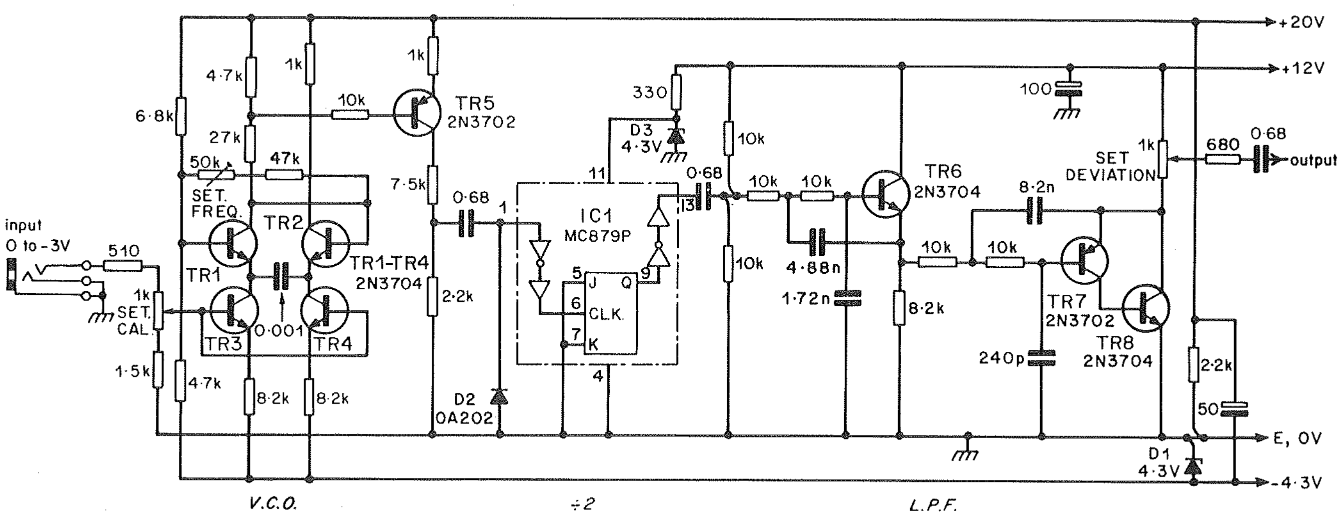

Fig. 4 - The voltage controlled oscillator and low pass filter

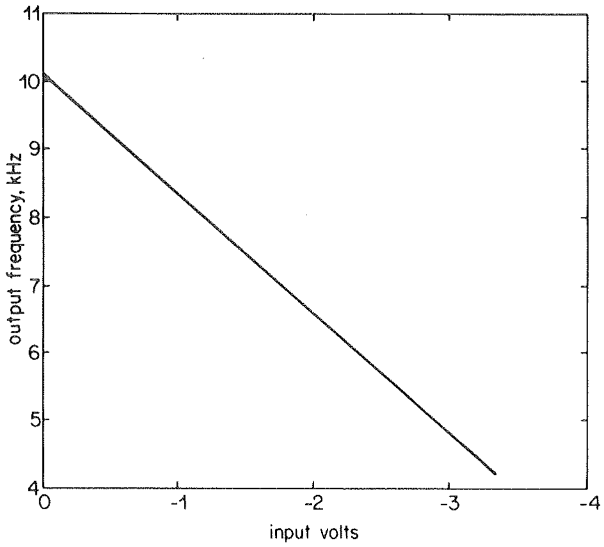

Fig. 5 - VCO characteristics

receiver[2] which produces a voltage proportional to the received field strength.

This voltage was converted by a voltage controlled oscillator (VCO) into a frequency ranging between 5 and 10 kHz which after filtering was used to modulate a Designs Department FM Drive Unit type EP7L/8.[3] The 5W output of the drive unit was fed to a co-axial dipole mounted on the superstructure of the buoy.

All equipment used on the buoy apart from the VCO, is fully covered in the references and will not be repeated here.

3.2. The VCO and low pass filter

The circuit diagram of the VCO and low pass filter is given in Fig. 4.

The LDR receiver gives an output of 0 to −3 V for a signal change of 60 dB. This voltage is applied to the bases of TR3 and TR4 to vary the frequency of the oscillator TR1 to TR4 over the range 10 to 20 kHz. The output of the oscillator is divided by two to give an equal mark to space ratio and is then filtered by the active low pass filter TR6, TR7 and TR8. A potentiometer on the output of the filter permits the deviation of the drive unit to be set. A plot of input voltage against output frequency is shown in Fig. 5.

3.3. The equipment at Portland Lighthouse

The frequency modulated transmission from the buoy was received at Portland Lighthouse on a 3 element Yagi aerial and detected by a medium distance recording receiver.[4] The tone modulation was extracted, decoded by a pulse counter and applied to one channel of a duplex recording milliammeter. An overall calibration from u.h.f. receiver input on the buoy to recording milliammeter is given in Fig. 6.

The frequency modulation system was adopted so that any variation of signal strength due to propagation between the Buoy and Portland Lighthouse was eliminated.

A second u.h.f. long distance recording receiver aligned on Channel 31 was installed at the Lighthouse and the output applied to the second channel of the recording milliammeter. Thus the chart gave a direct comparison between the signal as received at the Lighthouse and that received on the Buoy. The paths as shown in Fig. 2 are so similar that any variation between the received signals could, with a high degree of probability, be attributed to movement of the Buoy.

3.4. The tone decoder

A circuit diagram of the tone decoder is given in Fig. 7.

The audio frequency output of the v.h.f. medium distance recording receiver is amplified and limited by TR1, TR2, TR3 and TR4 before being divided by two by IC1. The output, varying between 2·5 and 5 kHz, is applied to the simple pulse counter comprising D3C1. The output of the counter is then applied to the operational amplifier IC2 which drives one channel of the duplex recording milliammeter.

In order to distinguish between drop-outs on the u.h.f. channel and on the v.h.f. telemetric circuit a pulse counter inhibitor TR5 and TR6 is used to reset the counter should the v.h.f. field strength drop to a low value. This drives the recording milliammeter to maximum signal whereas a drop-out on the u.h.f. channel will give zero.

4. Results

The equipment was installed on the buoy during September 1970 during the time that the buoy was being fitted out at Harwich. It was then towed to the Cork Hole in the North Sea for extensive sea trials but its position was such that no field strength measurements could be undertaken. On completion of the trials the buoy was taken to

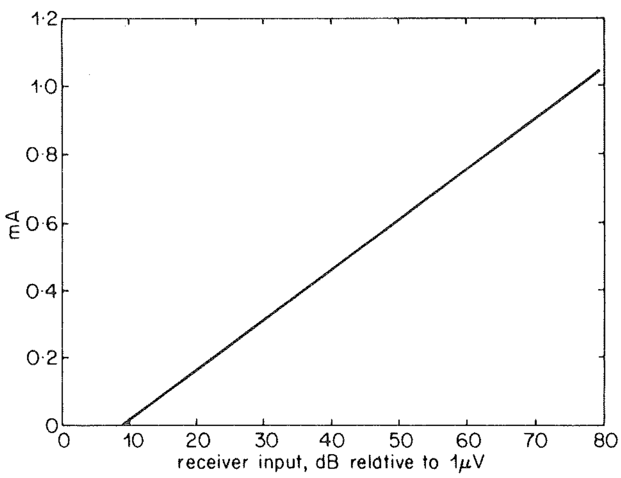

Fig. 6 - Overall calibration of system

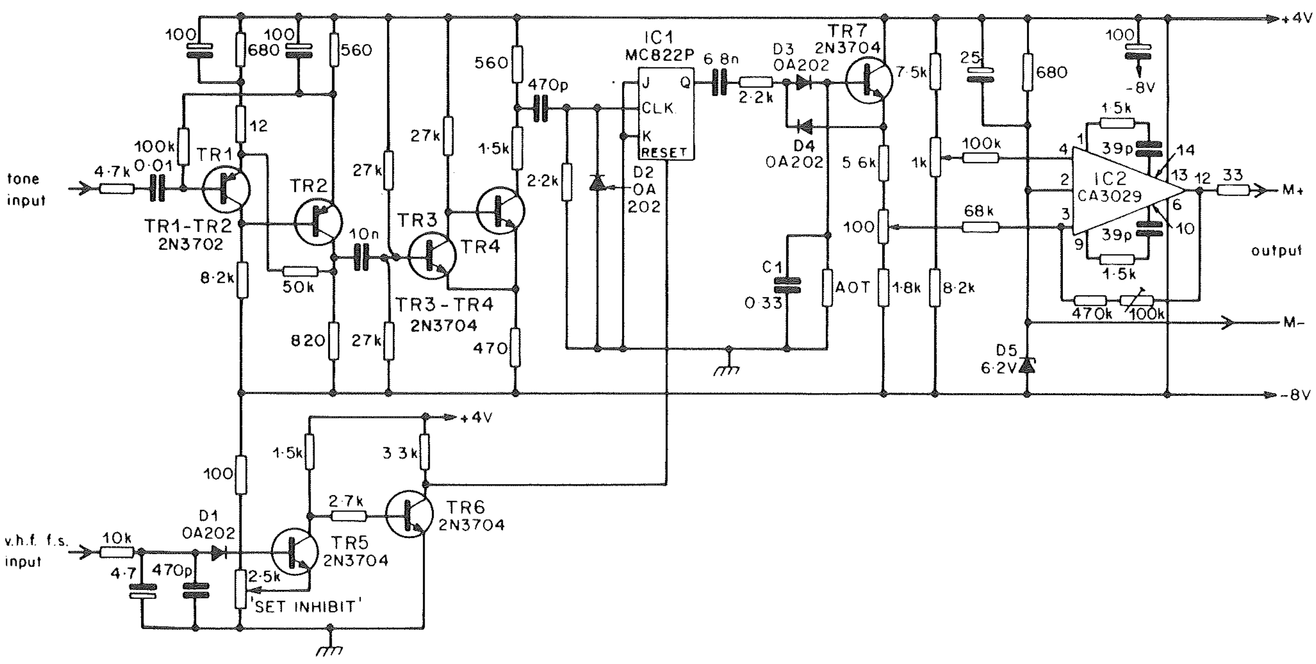

Fig. 7 - The tone decoder

the Royal Albert Dock and after further work was finally put on station at the Shambles during 1972 (due to circumstances beyond their control this represented a delay of nearly two years in the Trinity House timetable for this buoy).

By this time the results from the Buoy were largely of academic interest to the BBC as other methods under investigation were considered to be more practical. Nevertheless, a few test recordings were carried out before the experiment was terminated. A typical section of chart is shown in Fig. 8 from which it can be seen that the field strength as received on the buoy has a cyclic variation in addition to the variations due to propagation, caused presumably by wave motion of the sea surface. The termination of the experiment unfortunately leaves all questions regarding reception and onward relay of signals unanswered, but the few test recordings obtained showed that the telemetric system was operating satisfactorily. It is pertinent to note, however, that in the United States such buoys are used for radio relay purposes, and the authorities there have acquired much information relating to operation around the coasts of North America.

The buoy has a bridal mooring and American work indicates that the buoy can swing by anything up to 10°. Displacements from the vertical of 20° have been experienced in regular seas and on one occasion a displacement of 40° was recorded off the coast of Florida during a hurricane. The buoy is designed as a wave-rider and in consequence a vertical displacement equal to the wave height is to be expected. This can be as much as 15 m in the English Channel for a small percentage of the time.

The rotation and tilt of the buoy dictate the use of either a fairly wide aperture aerial for receiving and transmitting with consequent poor discrimination against interference or else some form of servo stabilised platform.

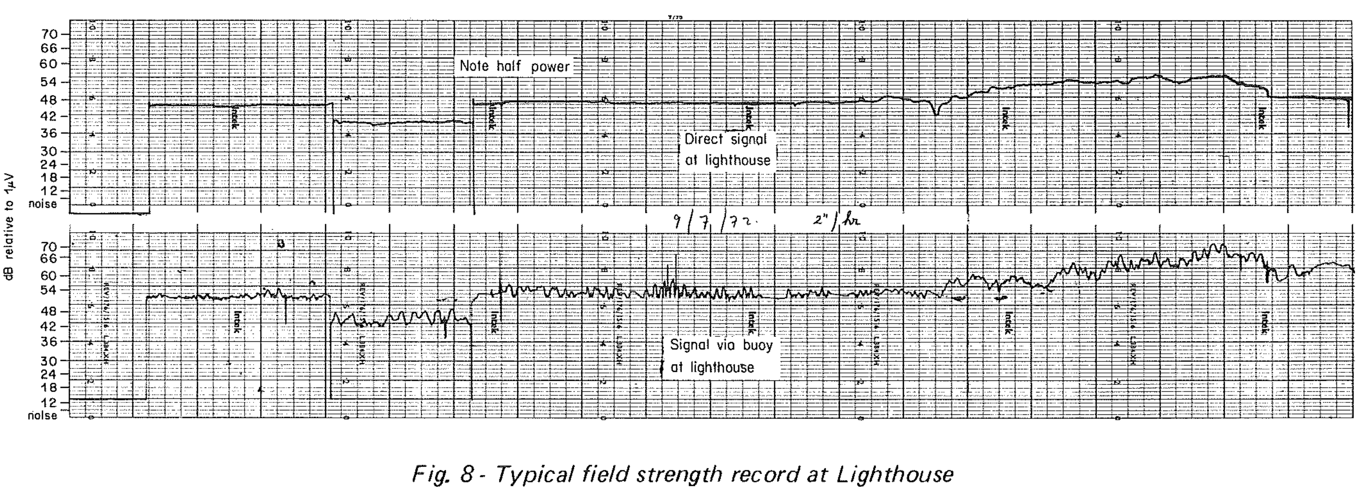

Fig. 8 - Typical field strength record at Lighthouse

The 15 m vertical displacement may be more of a problem for with a mast height of only 12 m, the aerials could be below mean sea level for part of the time.

Although the termination of the experiment before many results became available meant that few conclusions can be drawn, the preparatory work which included an assessment of current work elsewhere, provided a valuable insight into the possibilities.

5. Acknowledgements

The BBC wishes to place on record their thanks to Trinity House for permission to instal the equipment on the Lanby Buoy and for all the help provided by their staff both before and during the actual installation. Thanks are also due to the staff at Portland Lighthouse who looked after the shore equipment and returned the recorder charts to Kingswood Warren.

6. References

1. BEADLE, D.G., BROWN, A., KNIGHT, P., MONTEATH, G.D., PHILLIPS, G.J. *and* SUSANS, D.E. 1957. Aerials for field strength measurements in Bands I to IV. BBC Research Department Report No. E-057, Serial No. 1957/17 (out of print).

2. BEADLE, D.G. *and* SUSANS, D.E. 1963. UHF field strength measuring receivers. BBC Research Department Report No. K-164, Serial No. 1963/43.

3. EP7L/8 FM drives provisional handbook. BBC Designs Department Technical Memorandum No. 5.58 (70).

4. BEADLE, D.G., SUSANS, D.E. *and* DAVIS, B. 1962. Equipment for medium distance propagation tests in Bands I and II. BBC Research Department Report No. K-156, Serial No. 1962/42.

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